

AMTTRAK

Advanced Civil Speed Enforcement System

ACSES

- And -

Expanded Cab Signal System

Historical Perspective

- Four aspect Cab Signal System has been in service on the NEC for over 60 years
- Speed Control was added 40 years ago
- And then there were the Chase, Maryland and Boston Back Bay accidents
- To accommodate our new High Speed Train operation, Amtrak is:
 - Expanding the Cab Signal System to display more aspects
 - Adding an Advanced Civil Speed Enforcement System (ACSES)

System Overview

Expanded Cab Signal System

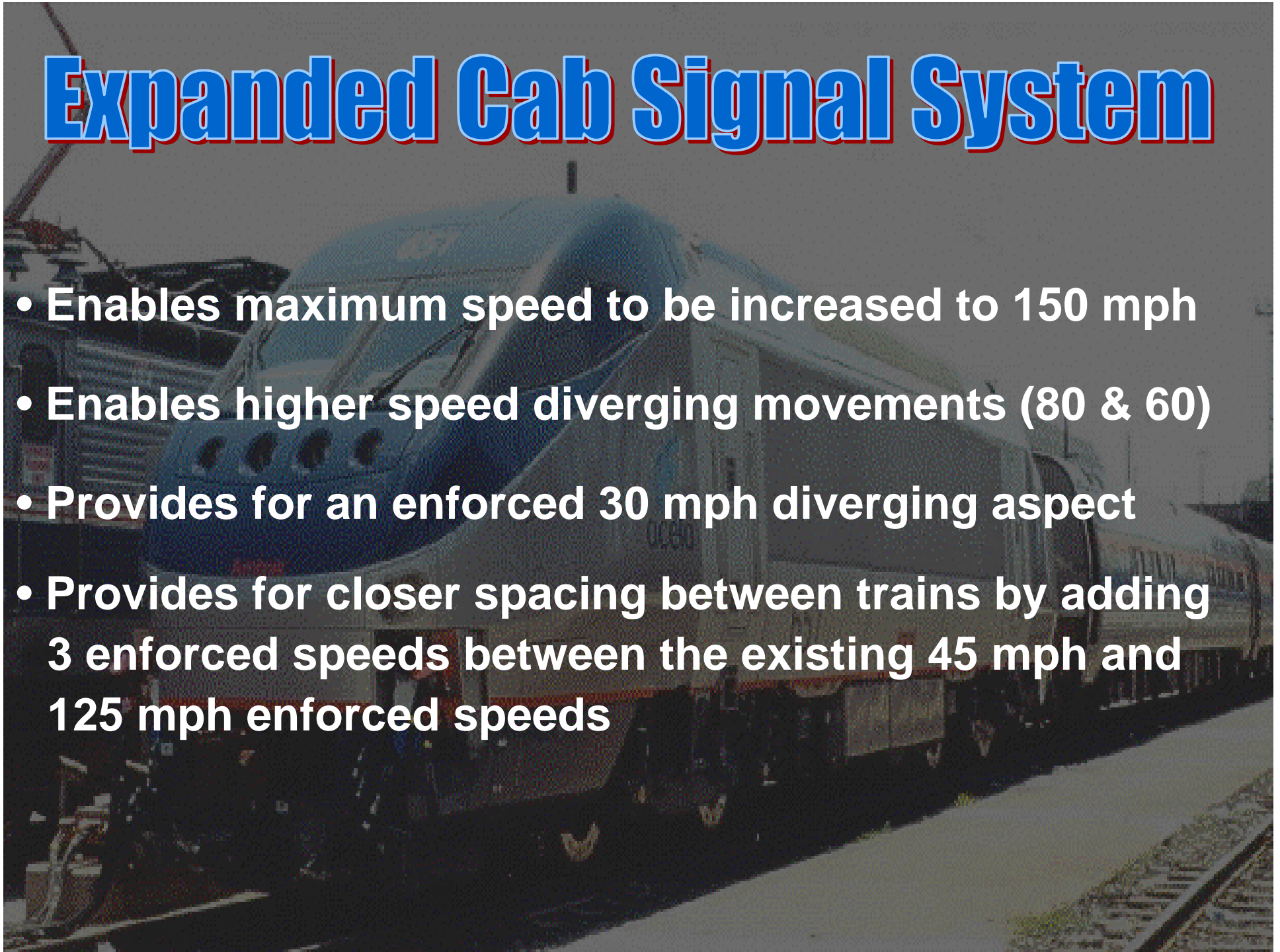
- Provides Safe & Efficient Train Separation
- Enforces Signal Speed Limits

ACSES

- Enforces Track Speed Limits
- Enforces Positive Stop at Interlocking and Controlled Point Signals

Expanded Cab Signal System

- Enables maximum speed to be increased to 150 mph
- Enables higher speed diverging movements (80 & 60)
- Provides for an enforced 30 mph diverging aspect
- Provides for closer spacing between trains by adding 3 enforced speeds between the existing 45 mph and 125 mph enforced speeds



ACES

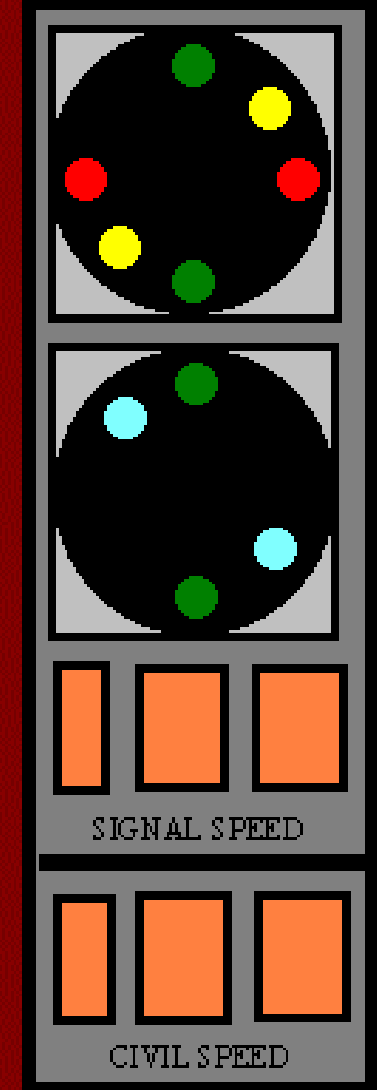
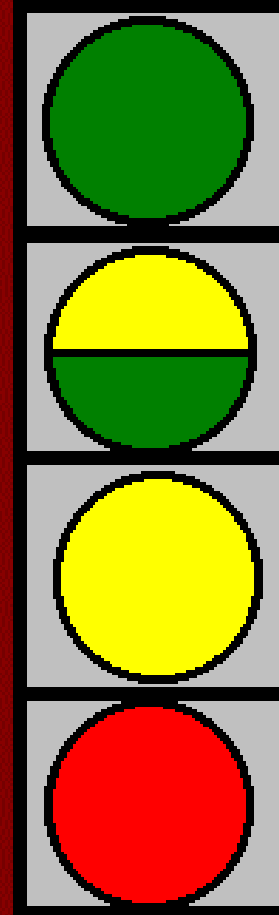
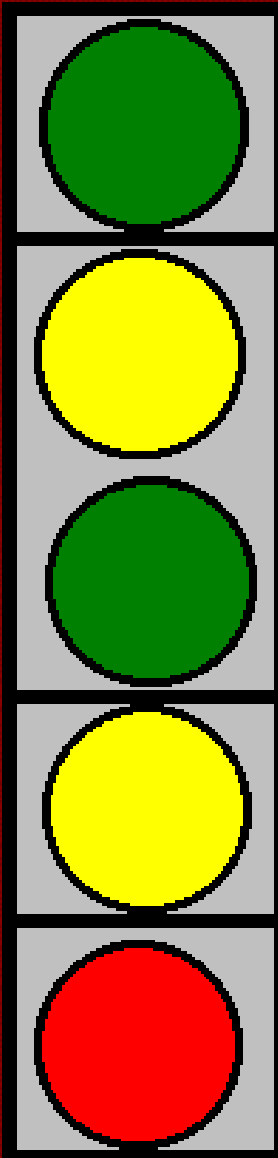
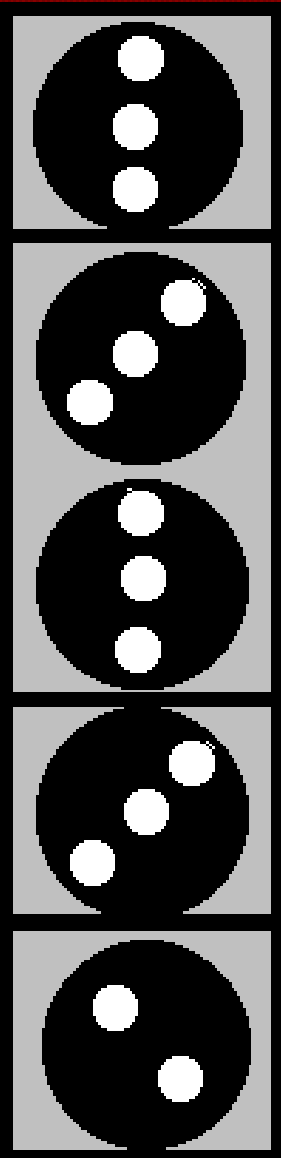
- Enforces permanent & temporary speed limits
- Enforces a positive stop at interlocking and CP signals displaying Stop Signal or Stop and Proceed
- Provides miscellaneous functions:
 - Disables and enables HST tilt system where required by clearance restrictions
 - Can open & close MCB for catenary dead sections and catenary voltage change points
 - Uses transponders and train speed information to update wheel diameter information
 - ACSES event recorder records all data received

Expanded Cab Signal System With ACSES

- ACSES & Cab Signal systems operate independently
- A new Aspect Display Unit (ADU) has been added to accommodate both systems
- Both systems provide speed enforcement, with the more restrictive speed prevailing
- The only time two systems interact is when Positive Train Stop (PTS) is requested by ACSES
- When Cab Signals are cut out, the ACSES system continues to perform certain safety functions

Typical 4-Aspect Cab Signal Displays

New Expanded Cab Display



ADU

Signal Speed →

Track Speed →

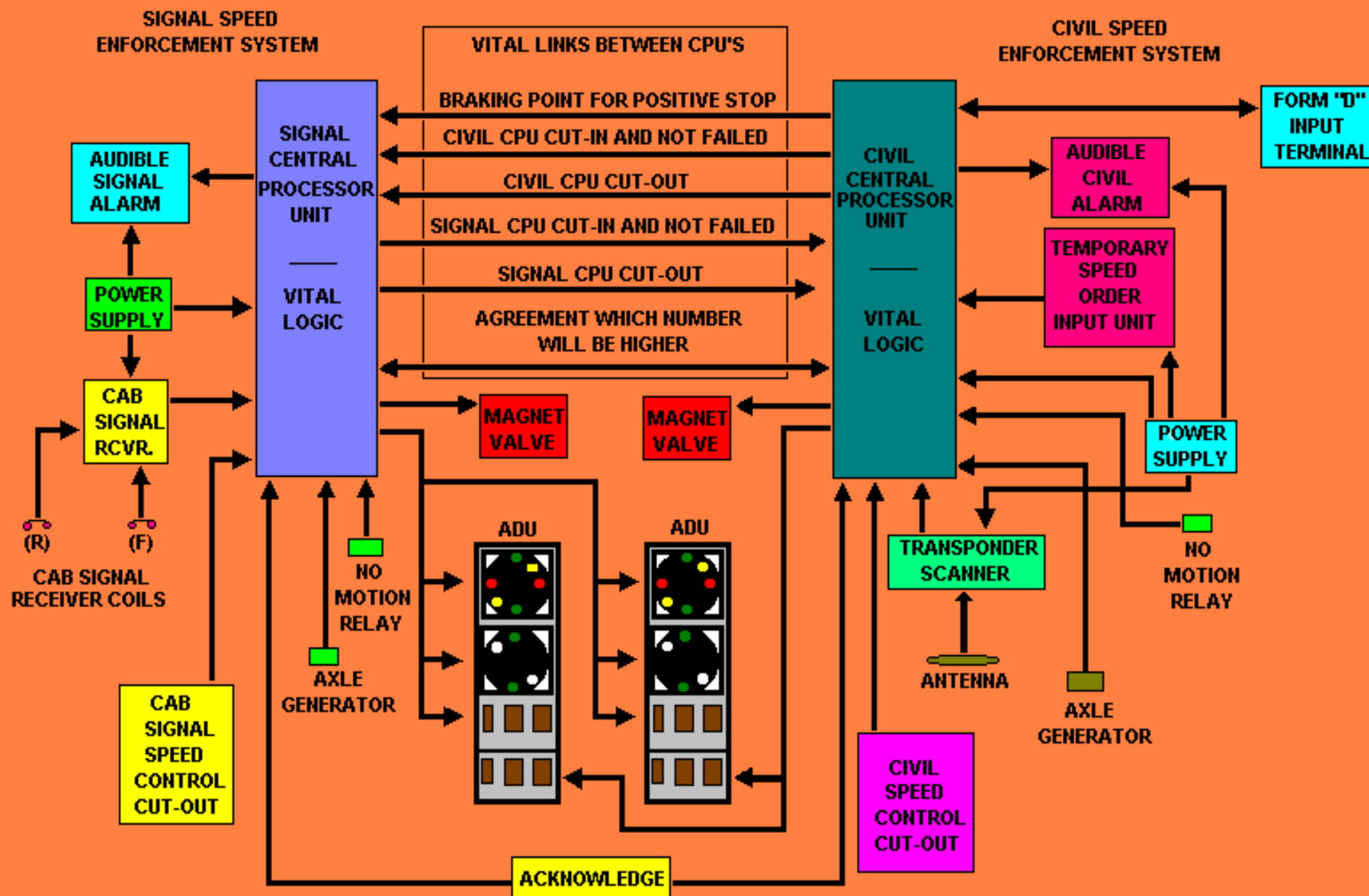


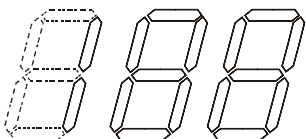
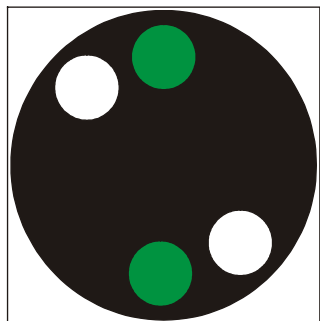
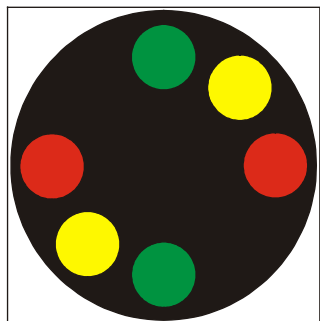
↑
Cab Signal

ACSES



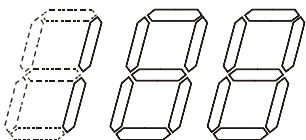
Functional Block Diagram Showing Required Vital (Fail-Safe) Interaction of On-Board Equipment





SIGNAL SPEED

● CUT OUT CUT IN ●

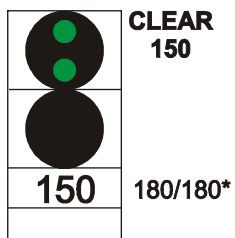


CIVIL SPEED

● CUT OUT CUT IN ●

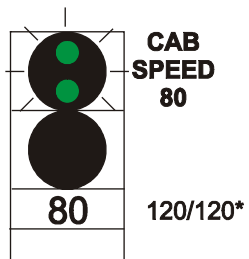
VZ

BRAKE RATE



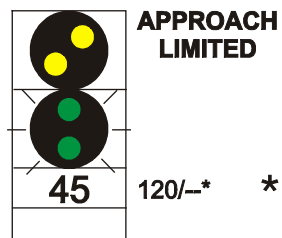
**CLEAR
150**

180/180*



**CAB
SPEED
80**

120/120*



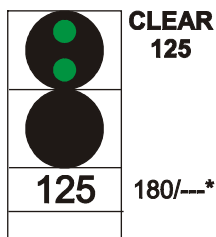
**APPROACH
LIMITED**

120/--*

**

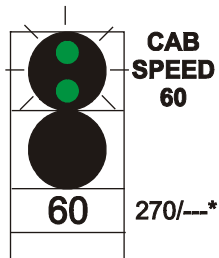


**RESTRICTING
--/--***



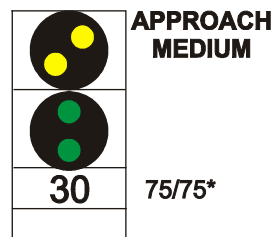
**CLEAR
125**

180/--*



**CAB
SPEED
60**

270/--*



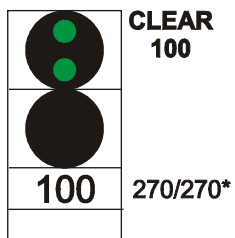
**APPROACH
MEDIUM**

75/75*



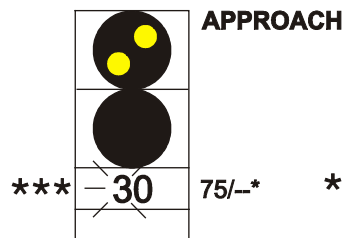
**STOP SIGNAL
--/--***

STOP TO BE ENFORCES
WITHIN 500 FEET OF HIGH
SPEED INTERLOCKING HOME
SIGNAL DISPLAYING
'STOP SIGNAL',
'STOP & PROCEED'
OR RESTRICTING



**CLEAR
100**

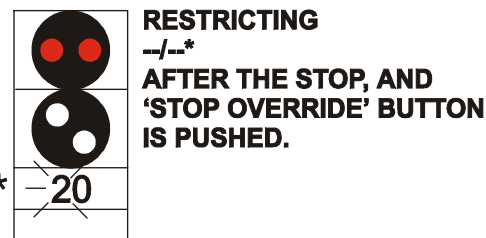
270/270*



APPROACH

75/--*

**



**RESTRICTING
--/--***

AFTER THE STOP, AND
'STOP OVERRIDE' BUTTON
IS PUSHED.

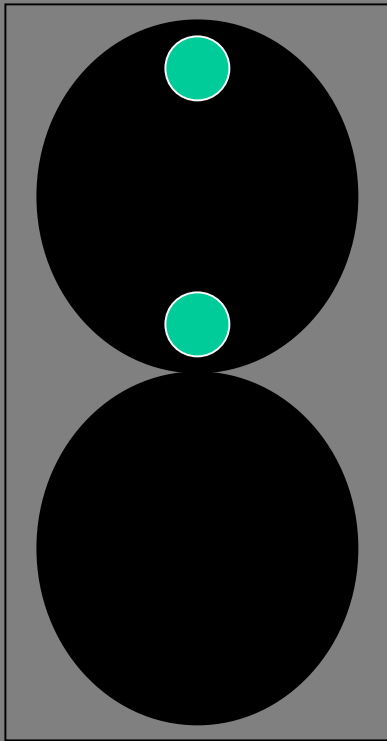
CIVIL SPEEDS NOT
SHOWN IN ABOVE
ILLUSTRATIONS

** TRACK CODES
100HZ / 250HZ

*** "30" TO BE DISPLAYED
FOR 6 SECONDS, THEN '0'
FOR 2 SECONDS

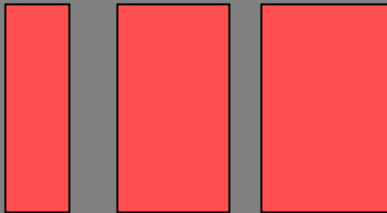
** "20" TO BE DISPLAYED
FOR 4 SECONDS, THEN '0'
FOR 2 SECONDS.

**Amtrak
CAB DISPLAY
CONTINUOUS SIGNAL / INTERMITTENT CIVIL
SPEED CONTROL SYSTEM**



1 5 0

SIGNAL SPEED



TRACK SPEED

CLEAR 150

CONFORMING FIXED SIGNAL:

CLEAR

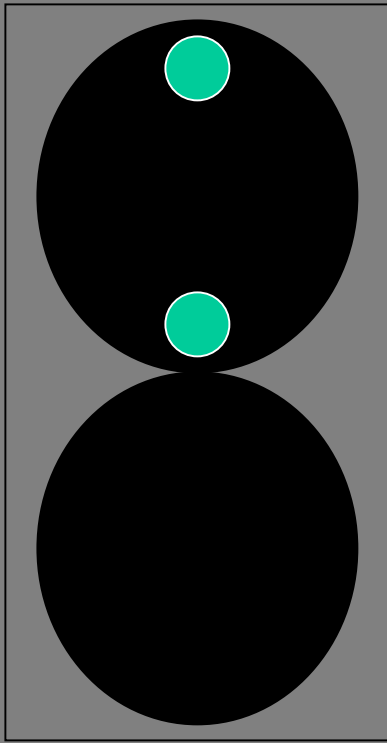
**CLEAR 150 WILL BE DISPLAYED
ONLY WHEN ACSES IS IN SERVICE**

CLEAR 125

CONFORMING FIXED SIGNAL:

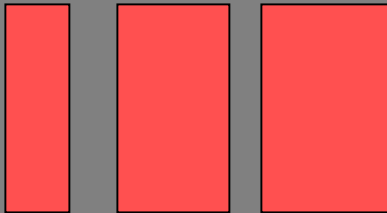
CLEAR

CLEAR 125 WILL BE DISPLAYED
IN BOTH ACSES AND NON-ACSES
TERRITORY



1 2 5

SIGNAL SPEED



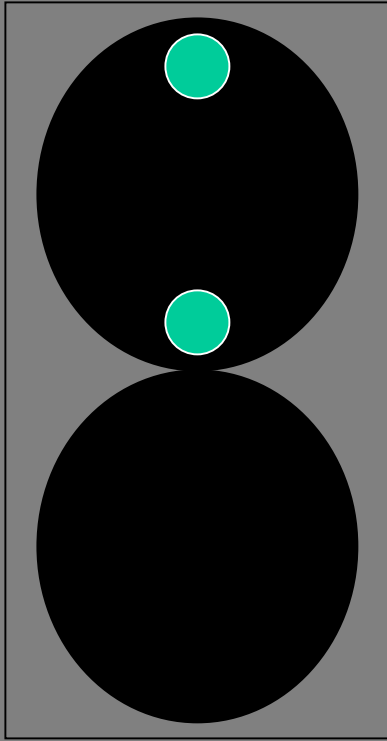
TRACK SPEED

CLEAR 100

CONFORMING FIXED SIGNAL:

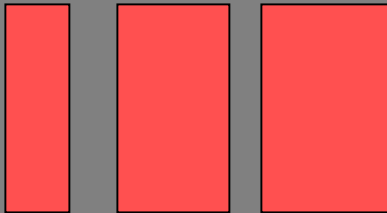
CLEAR

CLEAR 100 MAY BE DISPLAYED
WHEN NECESSARY TO BEGIN
REDUCING SPEED BECAUSE OF
A TRAIN, STOP SIGNAL, OR
DIVERTING ROUTE AHEAD



1 0 0

SIGNAL SPEED

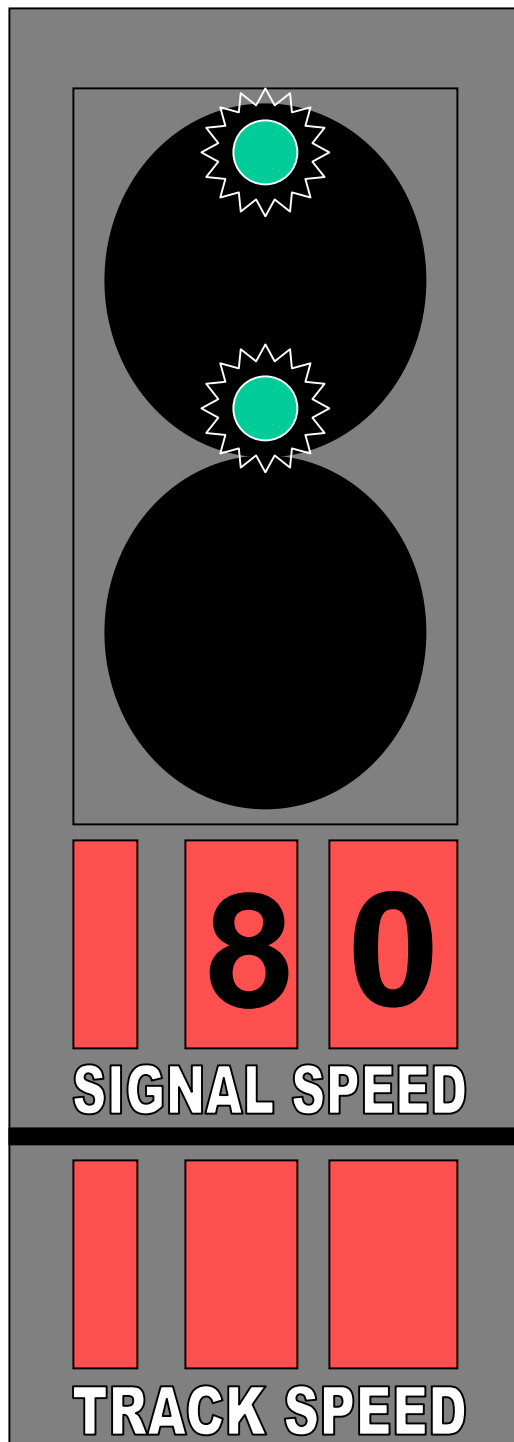


TRACK SPEED

CAB SPEED 80

**CONFORMING FIXED SIGNAL:
CAB SPEED**

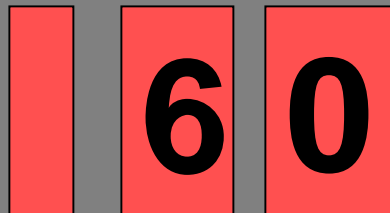
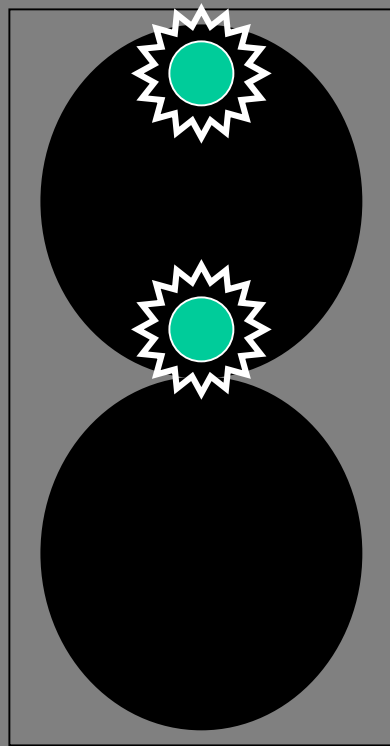
**CAB SPEED 80 MAY BE DISPLAYED
WHEN NECESSARY TO BEGIN
REDUCING SPEED BECAUSE OF A
TRAIN, STOP SIGNAL, OR DIVERTING
ROUTE AHEAD; OR TO ENFORCE THE
SPEED OF AN 80 MPH TURNOUT**



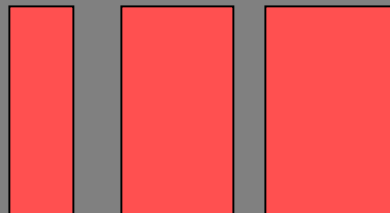
CAB SPEED 60

CONFORMING FIXED SIGNAL
CAB SPEED

CAB SPEED 60 WILL BE DISPLAYED
UNDER CIRCUMSTANCES SIMILAR TO
CAB SPEED 80



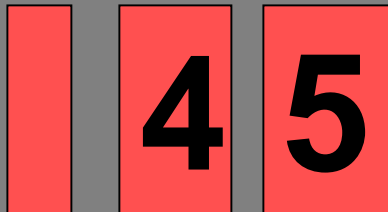
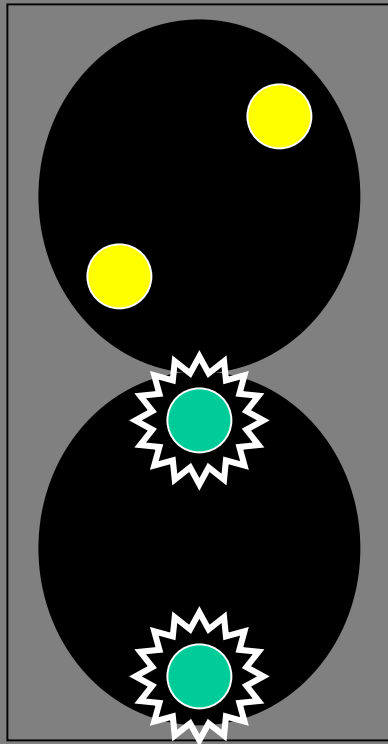
SIGNAL SPEED



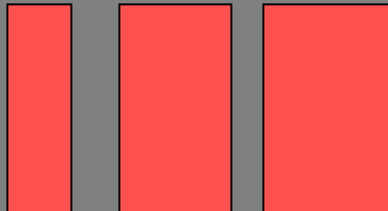
TRACK SPEED

APPROACH LIMITED

**CONFORMING FIXED SIGNALS:
CAB SPEED, LIMITED CLEAR,
APPROACH LIMITED,
ADVANCE APPROACH**



SIGNAL SPEED

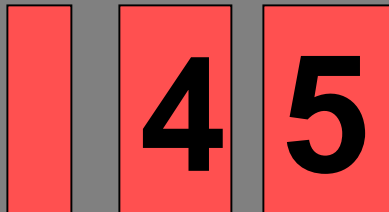
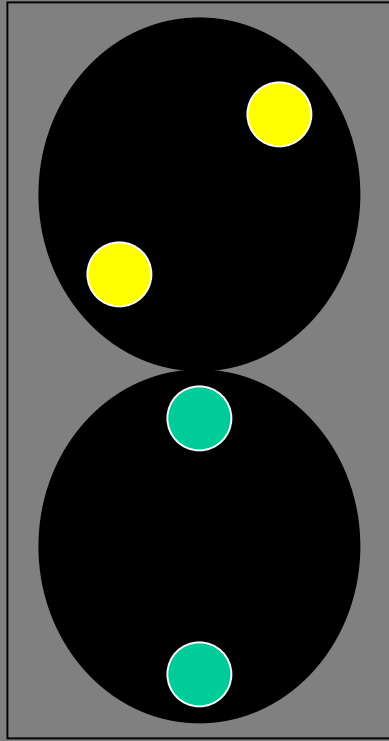


TRACK SPEED

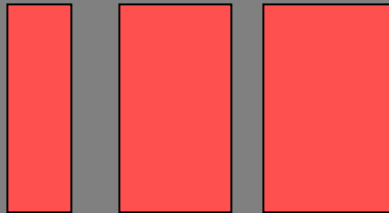
APPROACH MEDIUM 45

**CONFORMING FIXED SIGNALS:
CAB SPEED, LIMITED CLEAR,
MEDIUM CLEAR, APPROACH
LIMITED, APPROACH MEDIUM,
ADVANCE APPROACH**

**APPROACH MEDIUM WILL DISPLAY A
45 MPH SIGNAL SPEED UNTIL A NEW
CAB SIGNAL CODE IS INSTALLED AT
MEDIUM CLEAR FIXED SIGNALS.
ONCE THIS NEW CODE IS INSTALLED,
APPROACH MEDIUM 30 WILL BE
DISPLAYED TO CONFORM TO
MEDIUM CLEAR FIXED SIGNALS**



SIGNAL SPEED

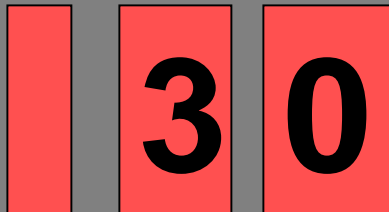
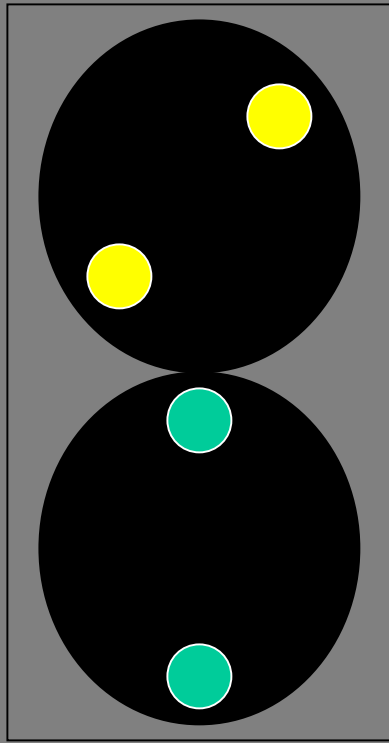


TRACK SPEED

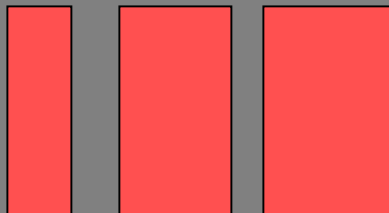
APPROACH MEDIUM 30

**CONFORMING FIXED SIGNAL:
MEDIUM CLEAR**

**THIS SIGNAL REQUIRES A NEW CAB
SIGNAL CODE THAT WILL BE
INSTALLED AT MEDIUM CLEAR FIXED
SIGNALS AFTER ALL TRAINS ARE
EQUIPPED WITH AN EXPANDED CAB
SIGNAL SYSTEM. THIS SIGNAL WILL
ENFORCE 30 MPH SPEED RESTRICTION
THROUGH MEDIUM SPEED TURNOUTS.**



SIGNAL SPEED



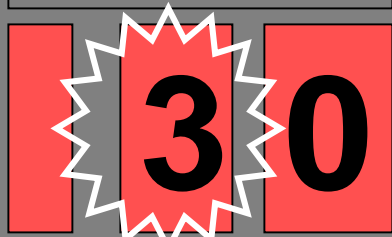
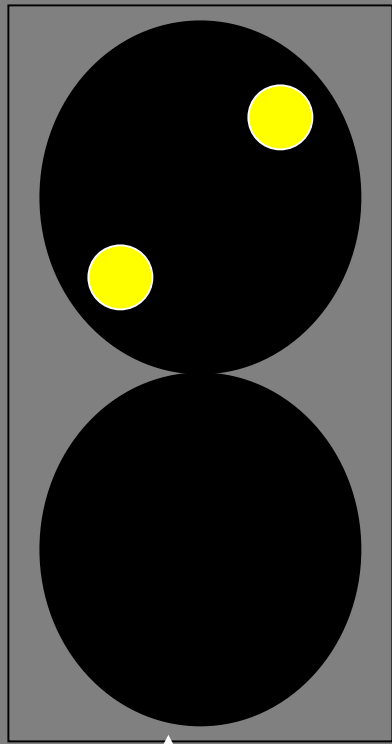
TRACK SPEED

APPROACH

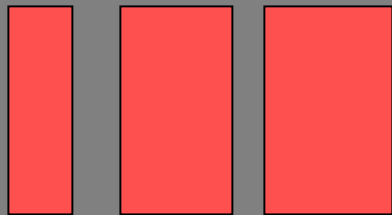
CONFORMING FIXED SIGNALS:
MEDIUM APPROACH, APPROACH
SLOW, APPROACH

THE SIGNAL SPEED WILL DISPLAY
30 FOR SIX SECONDS, THEN DISPLAY
0 FOR TWO SECONDS, THEN RETURN
TO 30.

NOTE: THE "3" IN THE "30" FLASHES.



SIGNAL SPEED



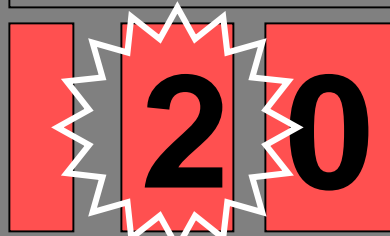
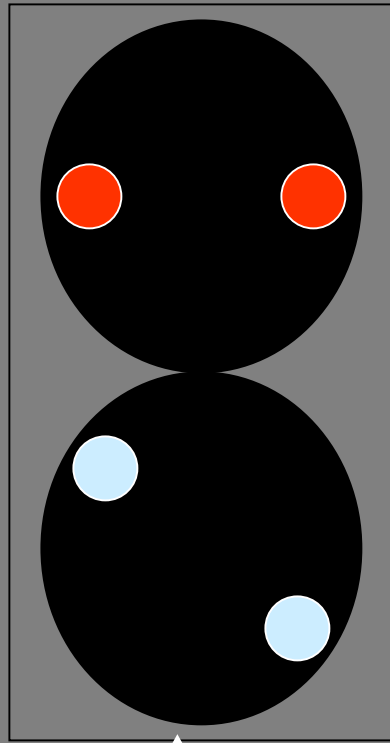
TRACK SPEED

RESTRICTING

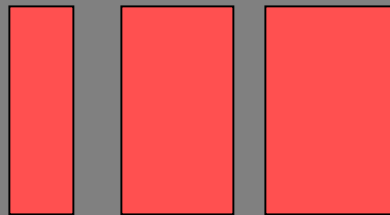
**CONFORMING FIXED SIGNALS:
SLOW CLEAR, SLOW APPROACH,
RESTRICTING, STOP & PROCEED,
STOP SIGNAL**

**THE SIGNAL SPEED WILL DISPLAY
20 FOR FOUR SECONDS, THEN
DISPLAY 0 FOR TWO SECONDS, THEN
RETURN TO 20**

NOTE: THE "2" IN THE "20" FLASHES.



SIGNAL SPEED



TRACK SPEED

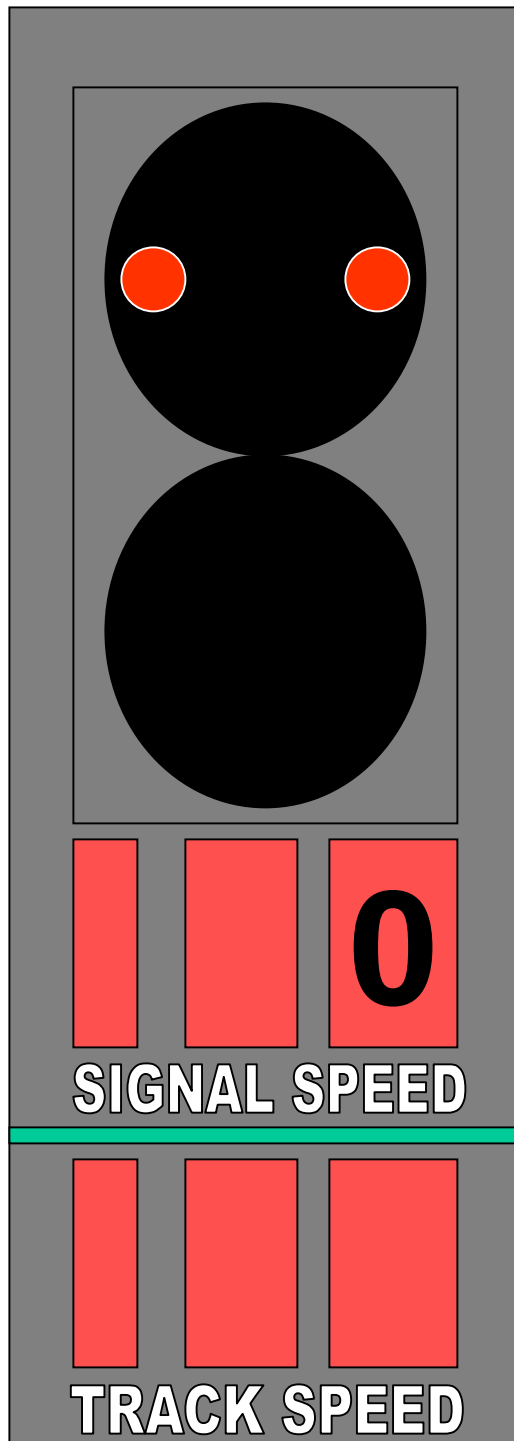
STOP SIGNAL

STOP SIGNAL WILL BE DISPLAYED ONLY IN TERRITORY WHERE ACSES IS IN SERVICE

STOP SIGNAL WILL BE DISPLAYED:

WHEN TRAIN IS APPROACHING A STOP SIGNAL OR STOP & PROCEED SIGNAL AT AN INTERLOCKING OR CP, AT A SPEED ABOVE BRAKING CURVE FOR HOME SIGNAL

WHEN TRAIN STOPS IN BLOCK PRIOR TO HOME SIGNAL, WITH RESTRICTING CAB SIGNAL OR CAB SIGNALS CUT OUT, AND BRAKES ARE RELEASED BEFORE STOP RELEASE BUTTON IS PRESSED



ACSES Territories

ACSES will be implemented on all main tracks between New Haven, CT and Boston, MA.

ACSES will be implemented gradually on the rest of the NEC, beginning with the following sections:

- County to Ham – Tracks 2 & 3
- Morris to Holmes – Tracks 2 & 3
- Ragan to Prince – Tracks 2 & 3
- Grove to Landover – Tracks 2 & 3

How Does it Work?

- An ACSES equipped engine continuously transmits a signal using an antenna mounted underneath the engine. This signal energizes transponders as the engine passes over them, and causes the transponders to transmit their encoded message.
- The encoded message is sent to the on-board computer.
- On-board computer calculates “alert curve” and “braking curve” for restriction, based on train speed and proximity of restriction.
- Speed restriction will appear on ADU prior to reaching location of restriction, if train speed reaches alert curve.
- Failure to acknowledge restriction and satisfy braking curve within 8 seconds (72 - 105 seconds for freight trains) will result in a penalty brake application. If penalty occurs, running release is permitted after train reaches speed of restriction.

What is Positive Train Stop?

- ACSES can enforce a Positive Train Stop (PTS) at home signals.
- Distant signal transponders advise on-board computer that train is approaching home signal, & convey distance to home signal.
- Using this data, on-board computer calculates alert curve & braking curve for speed restriction of “0” MPH at home signal.
- On-board computer enforces positive stop at home signal unless:
 - Cab signal aspect is more favorable than Restricting, or
 - “PTS Release” message is received from interlocking or controlled point data radio.

PTS With Restricting Cab Signal

- If train speed is 20 MPH or less anywhere between distant signal & home signal, on-board computer sends message via data radio to interlocking, requesting status of home signal aspect.
- If home signal is Restricting, train will be permitted to proceed at Restricted Speed without stopping.
- If home signal is Stop & Proceed, PTS will be enforced before home signal, then automatically released after train has stopped.
- If home signal is Stop Signal, PTS will be enforced before home signal, and Stop Release Button must be pressed to release PTS.
- After PTS has been released, ACSES will display and enforce 15 MPH Track Speed until train reaches transponder at far end of interlocking.
- If train stops between distant signal & home signal with Restricting in cab, PTS will be enforced if brakes are released before “PTS Release” message is received from interlocking data radio, or Stop Release Button is pressed.

PTS With Cab Signals Cut Out

- If train has cab signals cut out between distant signal & home signal, on-board computer sends message via data radio to interlocking, requesting status of home signal aspect.
- In territory where Rule 562 is **not** in effect, train will be permitted to proceed if home signal is more favorable than Stop & Proceed.
 - If home signal **is** Stop & Proceed, PTS will be enforced before home signal, then automatically released after train has stopped.
- In territory where Rule 562 **is** in effect, train will be permitted to proceed only if Clear to Next Interlocking signal (Rule 280a) is displayed.
- If train stops between distant signal & home signal with cab signals cut out, PTS will be enforced if brakes are released before “PTS Release” message is received from interlocking data radio, or Stop Release Button is pressed.

Data Radio Not in Service

- If interlocking or on-board data radio is not in service, trains with Restricting cab signal or with cab signals cut out will be stopped before home signal, regardless of signal aspect.
- If train stops between distant signal and home signal with Restricting cab signal or cab signals cut out, Stop Release Button must be pressed in order to proceed.
- After Stop Release Button has been pressed to release PTS, ACSES will display & enforce Track Speed of 15 MPH until train reaches transponder at far end of interlocking.
- Until data radios are in service at most interlockings, SI will require trains with failed cab signals to cut out ACSES.

What are Transponders ?

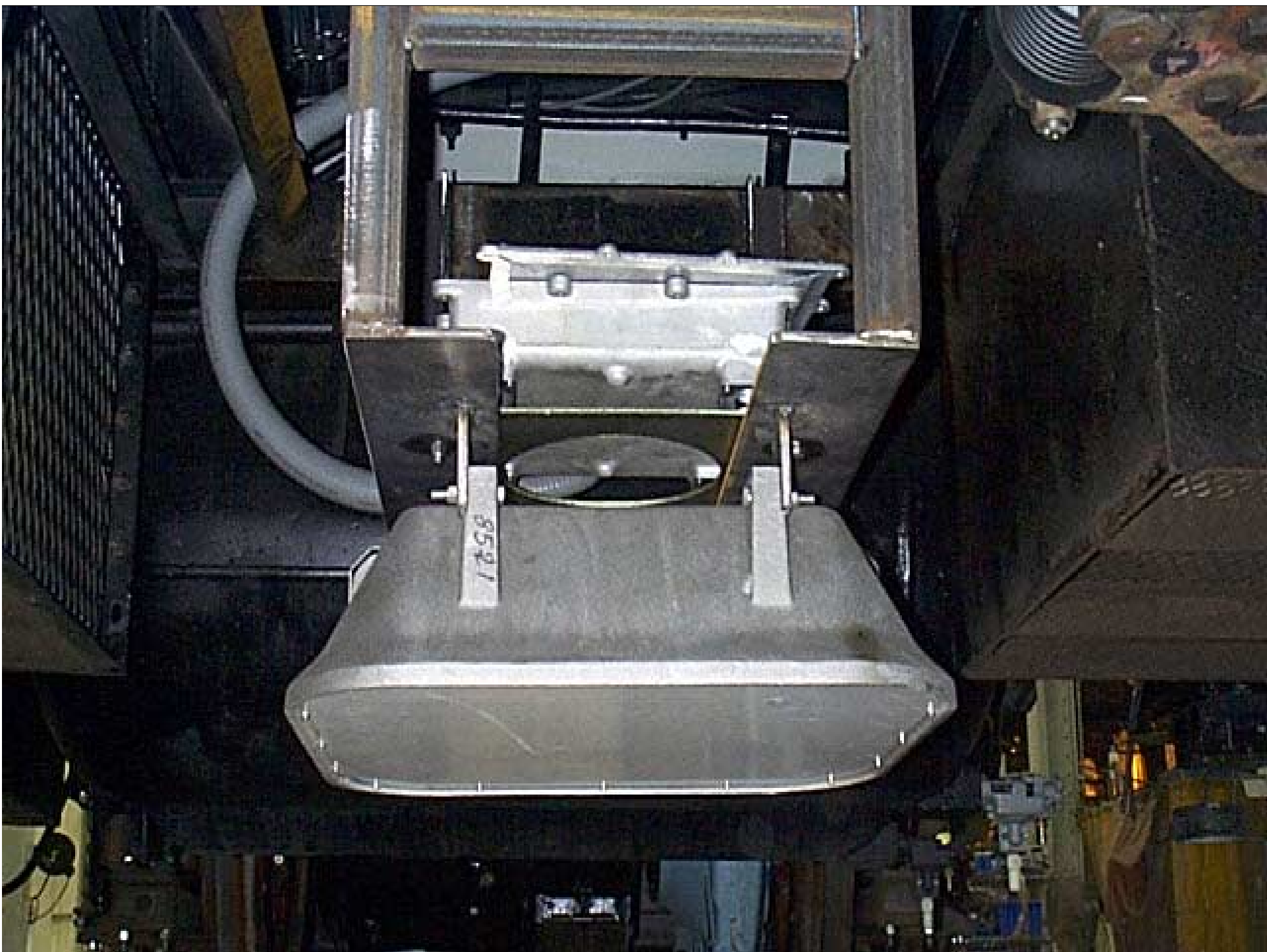
Transponders are passive devices that require no energy source other than that of a passing train. They are permanently fastened in the gauge of the track on top of the ties, in sets of at least 2.

Transponder Messages

Basic information encoded in transponder:

- **Track location and transponder ID code**
- **Current track speed for each train type**
- **Distance to the next transponder set**
- **Distance, location and requirements for upcoming track speed change(s)**
- **Grade**
- **Data bytes that enable system to verify that message was received correctly**

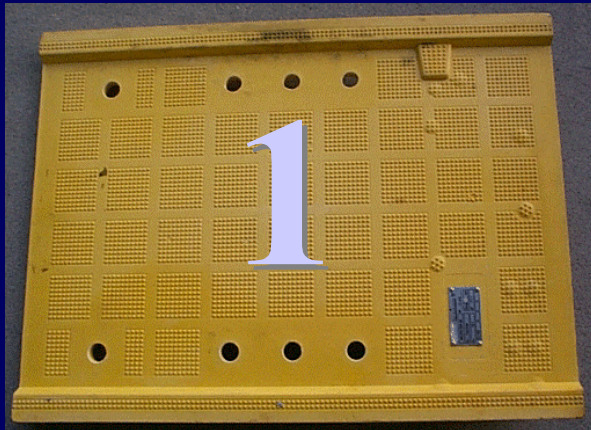




ACSES

Operation

- Determine Direction



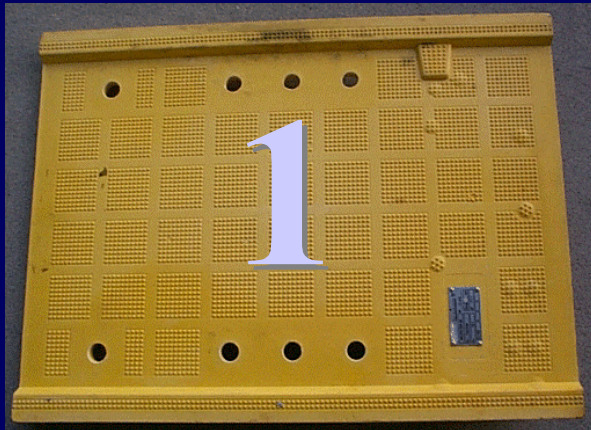
Up



ACSES

Operation

- Determine Direction



← Down

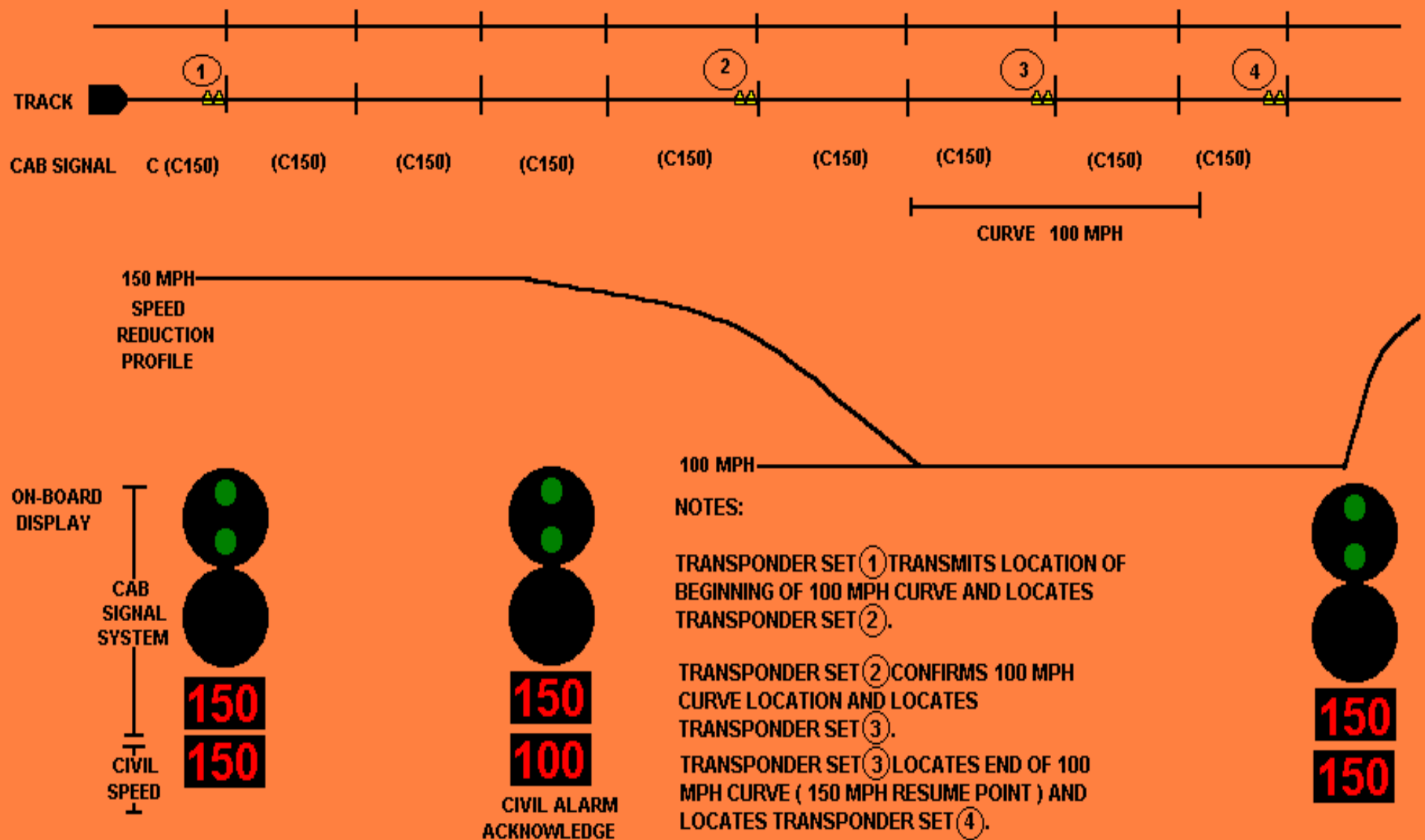
ACSES

Operation

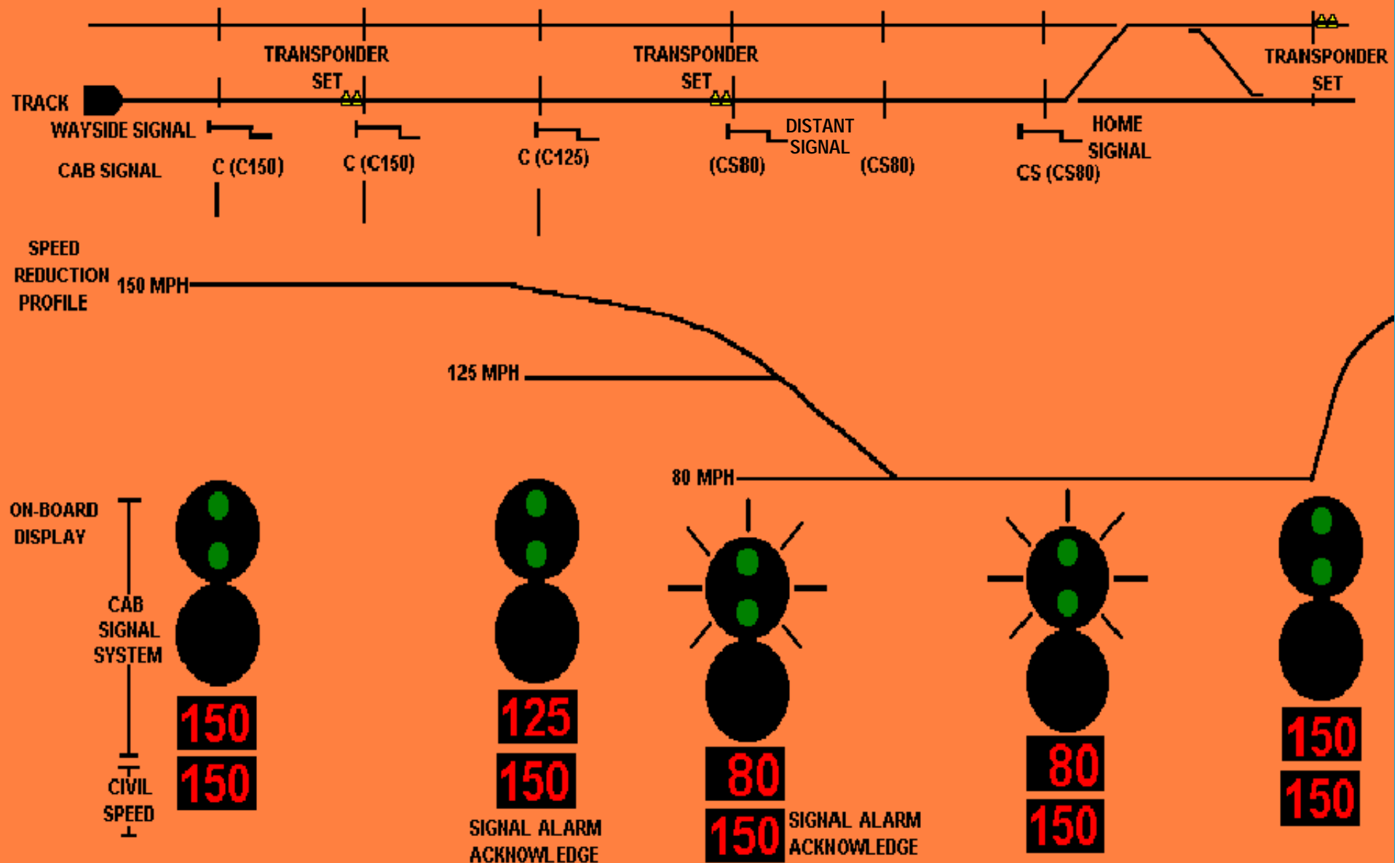
- Linking Distance



TYPICAL APPROACH TO 100 MPH CURVE 150 MPH TERRITORY

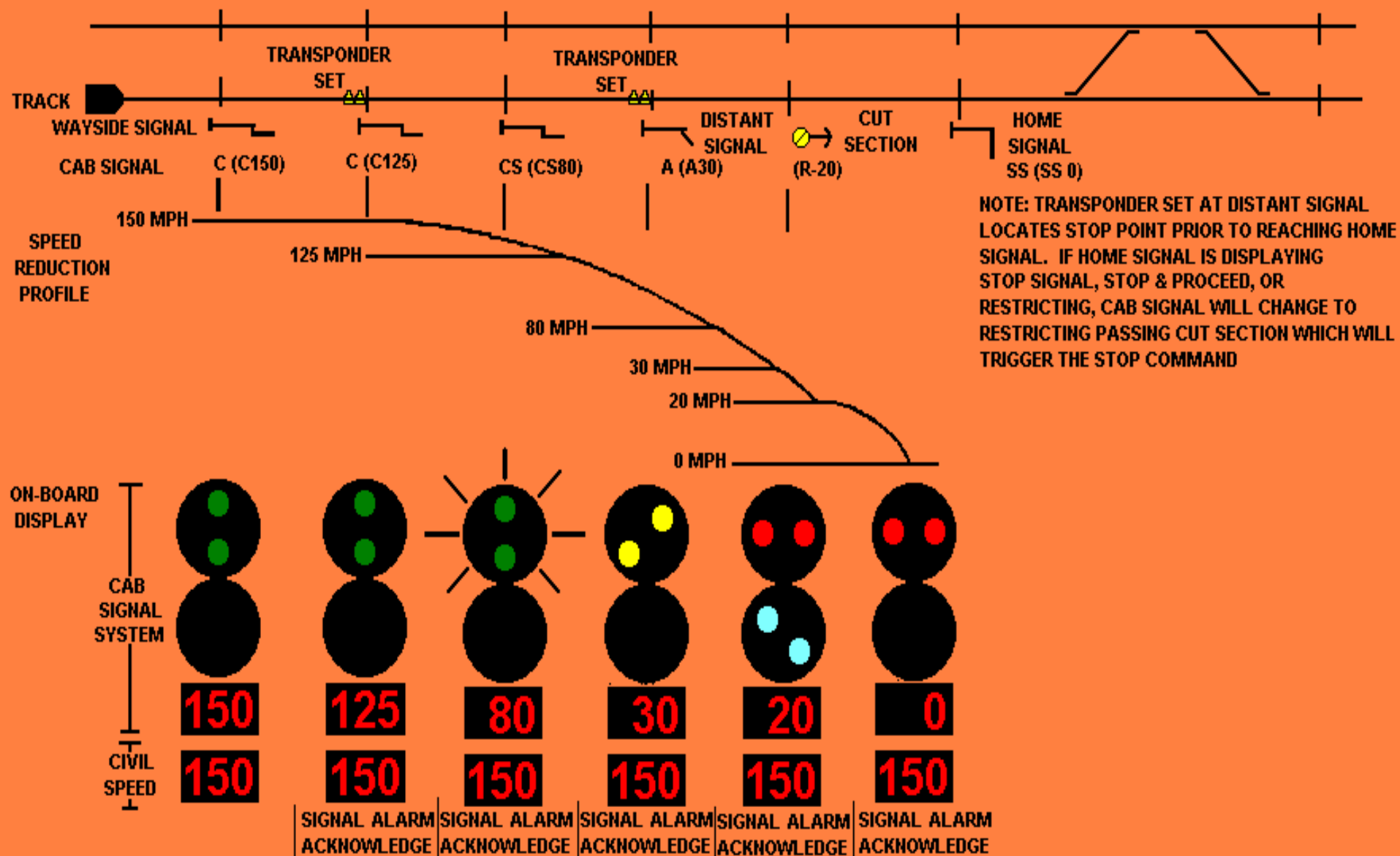


TYPICAL APPROACH TO 80 MPH CROSSOVER 150 MPH TERRITORY



TYPICAL APPROACH TO STOP SIGNAL

150 MPH TERRITORY



CAB SIGNAL OPERATING NORMALLY, ACSES SYSTEM WILL:

Permit speed increase from 110 mph to 150 mph (NED), or from 125 mph to 150 mph (MAD, MET)

Display and enforce track speeds

**Display and enforce
Stop Signals**

Release PTS if cab signal aspect is better than Restricting

CAB SIGNAL INOPERATIVE, ACSES SYSTEM WILL:

Limit maximum speed to 79 mph

Display "--" in track speed indicator, but continue to enforce track speeds below 79 mph

Enforce PTS at home signals. Data radio will be used to release PTS when appropriate, and to enforce crossover speeds

Special Instructions will require ACSES to be cut out, until data radio release is implemented

ACSES ON-BOARD COMPONENTS

On-Board Vital Computer

ACSES Display

Full Service Brake Loop

Cab-Signal System Interface

Train Type Selector Switch

ACSES Cut-In/Cut-Out Switch

Acknowledge Button

Axle Generator for Speed Sensing

Data Radio

Data Radio Antenna

ACSES Transponder Antenna

Train Type Selector Switch

- Most engines and control cars will be equipped with a “Train Type Selector Switch,” which must be properly positioned by the engineer at the beginning of each trip.
- Position of Train Type Selector Switch will tell on-board ACSES computer which Timetable speeds to enforce.
- There are 5 train types:
 - A = High Speed Trainset with tilt enabled
 - B = High Speed Trainset with tilt **disabled**, and equipment covered under old Timetable “Column A” definition
 - C = Equipment covered under old Timetable “Column B” and “Column C” definitions
 - D = Trains meeting new Mail, Baggage & Express Train definition
 - E = Freight, including wreck and work trains.

Permanent Transponders

Permanent transponders:

- Convey permanent track speed information to on-board ACSES equipment, according to maximum speeds & speed restrictions listed in Timetable.
- Advise trains when they are approaching an interlocking, so that the stop enforcement feature of ACSES can be activated, when necessary.
- Will be programmed, installed and tested by C&S prior to implementation of ACSES.
- Must be reprogrammed and retested when permanent track speeds are revised.

Temporary Transponders

- For first 12 months of high speed service, temporary transponders will be used to convey temporary speed restriction information to on-board ACSES equipment, according to TSRB and Form D speed restrictions.
- Temporary transponders will be installed by Track Department employees, when and where temporary speed signs are installed.
- When train passes temporary transponder, speed restriction will be displayed and enforced immediately, regardless of train speed. (No braking curve will be calculated.)
- Engineers must make full service application to satisfy braking rate and forestall penalty.

Use of Data Radio to Enforce Temporary Speed Restrictions

- After first 12 months of high speed service, data radios will be used to convey temporary speed restriction information to on-board ACSES equipment, according to TSRB and Form D speed restrictions.
- Temporary speed restriction data will be entered into ACSES data radio system directly by the Train Dispatcher.
- On-board equipment will calculate alert & braking curves for temporary restrictions received by data radio, and display and enforce them in the same manner as permanent restrictions.

Use of Data Radio to Transmit Interlocking Signal Information

Data Radios will be installed at all interlockings to transmit signal information to approaching trains:

- Trains with a Restricting cab signal will need this information to release PTS enforcement when the interlocking signal is displaying Stop & Proceed or Restricting.**
- Trains with inoperative cab signals will need this information to release PTS enforcement when interlocking signal and/or “C” light (Rule 280a) permit, and to enforce speed through interlocking turnouts.**

Data Radios will obtain signal information from encoders which monitor interlocking signal and “C” light status.

ACSES Operating Rules

- All trains operating in ACSES territory must be equipped with on-board ACSES apparatus, unless otherwise provided by Special Instructions
 - When ACSES is initially implemented between New York and Washington, only the High Speed Trainsets will have to be equipped
- ACSES on leading engine of train must be tested within 24 hours of engine leaving initial terminal
- Signed copy of test results must be left in engine cab and at test location
- If necessary en route to operate from equipped unit without 24 hour test, Rule 584 “Movement With Inoperative ACSES Apparatus” will apply

ACSES Should Conform to Track Speeds

- ACSES track speed indicator should conform to all permanent and temporary speed restrictions
- When approaching location where track speed decreases, on-board computer calculates alert & braking curves for restriction
 - If train reaches alert curve, restriction will appear on ADU, audible alarm will sound, and lower speed will be highlighted (yellow bar underneath, or red light to left)
 - Once restriction is displayed, engineer has 8 seconds (72 - 105 seconds for freight trains) to acknowledge and satisfy braking curve. Otherwise, a penalty application will occur.
- When approaching location where track speed increases, higher speed will not be displayed until train reaches location of speed change. Audible indicator will sound briefly, but will not require acknowledgement.

If ACSES Does Not Conform to Track Speeds

- There are 2 ways that ACSES can fail to conform to track speeds:
 - ACSES might display incorrect speed, or
 - ACSES might display missing transponder symbol “— —”
- If ACSES displays incorrect speed, the lower speed will apply
- If ACSES displays missing transponder symbol, train will operate according to track speed limits, not exceeding 110 MPH between New Haven and Boston, and 125 MPH between New York and Washington
- Engineer must notify Dispatcher of non-conformity as soon as possible, without delay to train
- Dispatcher must notify C&S and Mechanical personnel
- Normal speed may be resumed once correct speed is displayed

ACSES Enforcement of Home Signals

- ACSES will enforce PTS at interlocking or CP signals displaying Stop Signal or Stop & Proceed.
- Until data radios are in service at interlockings and CP's, ACSES will also enforce PTS at Restricting signals.
- ACSES will cause a penalty brake application if train:
 - Approaches signal at speed above braking curve
 - Stops in block prior to signal with Restricting cab signal or cab signals cut out, and releases brakes before pressing Stop Release Button.

ACSES Enforcement of Home Signals

- After train has stopped for interlocking or CP signal displaying Stop Signal or Stop & Proceed (or Restricting, if no data radio in service), Engineer must press Stop Release Button to proceed.
- For fixed signals displaying Stop Signal, Stop Release Button must not be pressed until train has received Rule 241 permission to pass Stop Signal.
- Once Stop Release Button has been pressed, ACSES will display and enforce 15 MPH track speed until engine clears interlocking or CP.
- After data radios are in service, no stop will be required for Restricting signals, and stop release for signals displaying Stop and Proceed will occur automatically within 10 seconds after train has stopped.

Inoperative ACSES On-Board Apparatus

Movement of train equipped with inoperative ACSES on-board apparatus is prohibited, except when failure occurs after leaving initial terminal.

ACSES on-board apparatus will be considered as having failed if any of the following conditions occur:

- Audible indicator fails to sound when ACSES display changes to more restrictive speed.**
- Audible indicator continues to sound after change acknowledged and speed of train reduced to speed required.**
- ACSES displays an incorrect speed for 3 permanent speed changes in succession.**
- Damage or fault occurs to any part of ACSES apparatus (e.g., transponder antenna is damaged, ACSES display unit goes dark, etc).**

Engineer's Responsibility When ACSES Failure Occurs

When ACSES on-board apparatus fails en route, Engineer must take the following actions:

- **Cut out ACSES on-board apparatus.**
- **Not exceed 110 MPH between New Haven and Boston, and 125 MPH between New York and Washington.**
 - **In addition to these speed limits, High Speed Trainsets must not exceed speeds authorized for non-tilting passenger trains in next lower speed category.**
- **Notify Dispatcher and Conductor of reason and location of failure, as soon as possible without delay to train.**
- **Consider ACSES on-board apparatus as inoperative until repaired, tested, and found to be functioning properly.**

Dispatcher's Responsibility When ACSES Failure Occurs

Dispatchers who are notified of an ACSES on-board apparatus failure must promptly:

- Notify appropriate Mechanical and Signal personnel of reason and location of failure.**
- Notify Dispatcher of connecting dispatching district.**

ACSES Operation With Failed Cab Signals

ACSES will function differently on trains with cab signals cut out because of en route cab signal failure:

- **Missing transponder symbol “– –” will be displayed continuously, except when “0” is displayed for stop enforcement**
- **ACSES will continue to enforce track speed limits, and home signals displaying Stop Signal or Stop & Proceed**
- **ACSES will enforce Slow Speed, Medium Speed and Limited Speed routes within interlocking limits**
- **ACSES will enforce positive stop at home signals governing entrance to Rule 562 territory, when “C” light (Rule 280a) is not displayed.**

Circumstances in Which ACSES May Not Indicate Current Conditions

- *When train enters ACSES territory at hand-operated switch or makes reverse move in ACSES territory, ACSES may not display correct track speed until engine passes first transponder set.*

Movement must not exceed 20 MPH until valid speed is displayed.

- *When train makes diverting move at interlocking, ACSES may not display correct speed of track to which train is routed until train passes first transponder set on affected track.*
- *When train passes transponder while moving at less than 3 MPH, ACSES may display missing transponder symbol “— —”*

Wayside Portion of ACSES Not Operative

- If wayside portion of ACSES is inoperative, Dispatcher may issue Form D line 13 or verbal instructions to temporarily suspend ACSES Rules in affected area.
- Signal Department may install temporary transponders to automatically suspend operation of on-board ACSES apparatus within designated limits.
- Engineer must NOT manually cut out on-board apparatus.
- Movement within designated limits must not exceed 110 MPH between New Haven and Boston, and 125 MPH between New York and Washington.
- In addition to above speed limits, High Speed Trainsets must not exceed speeds authorized for non-tilting passenger trains in next lower speed category.

Reliance on ACSES

- Employees must not intentionally rely on ACSES to enforce compliance with track speeds or signal indications
- ACSES is intended to supplement, not replace, employee knowledge and skills

Dispatcher's Responsibility for Recording Movements

Dispatchers must record on Record of Train Movements:

- **Trains on which ACSES has failed to conform with track speeds**
- **Trains with failed ACSES apparatus**
- **Wayside portion of ACSES inoperative**

Engineer's Responsibility to Report on Forms

Engineers must report the following occurrences on the prescribed form, in addition to verbally reporting them to the Dispatcher:

- ACSES non-conformity to track speeds**
- Failure of ACSES on-board apparatus**